AD-A045 484 NAVY UNDERWATER SOUND REFERENCE LAB ORLANDO FLA F/G 17/1
ACOUSTIC MEASUREMENTS ON EDO 60-INCH LUCITE SONAR DOME,(U)
OCT 52 J M TAYLOR

UNCLASSIFIED USRL-25 NL

| OF |
AD
A045484

END
DATE
FILMED
11-77
DDC

UNDERWATER SOUND REFERENCE LABORATORY REPORT

ACOUSTIC MEASUREMENTS ON EDO 60-INCH LUCITE SONAR DOME

USRL REPORT NO. 25

8 October 1952

USRL PROJECT NO. AD-441

OFFICE OF NAVAL RESEARCH
U.S.N. UNDERWATER SOUND REFERENCE LABORATORY
P.O. BOX 3629, ORLANDO, FLORIDA

(6) ACOUSTIC MEASUREMENTS ON EDO 60-INCH LUCITE SONAR DOME

(10) by John M. Taylor, Jr.

◊ ◊ ◊

(14) USRL [redacted]-25
(11) 8 Oct[redacted] 52

USRL PROJECT NO. AD-441

(12) 35 p.

254 300

U. S. NAVY UNDERWATER SOUND REFERENCE LABORATORY
O. M. Owsley, Director
P. O. Box 3629 Orlando, Florida

ABSTRACT

Measurements made to determine the acoustic properties of a 60 inch lucite dome manufactured by the Edo Aircraft Corporation are presented. The results indicate that the dome is acoust[illegible]y unsuitable for use with sonar equipment o[illegible]g at frequencies above about 10 kc.

Table of Contents

Illustrations

ACOUSTIC MEASUREMENTS ON EDO 60-INCH LUCITE SONAR DOME

INTRODUCTION

The USRL was requested by the Bureau of Ships[1] to make a series of measurements on a 60-inch lucite sonar dome manufactured under contract NObsr-42120 by the Edo Corporation. Preliminary examination of Edo's proposal by the Bureau of Ships, the Naval Research Laboratory, and the Underwater Sound Reference Laboratory had indicated that lucite was not a very satisfactory material for such a purpose on the basis of either structural properties or acoustical properties, but the idea of manufacturing domes of molded plastic material was such an appealing one from the standpoint of simplicity and low cost that some hope remained that the experimental model would prove to be useable.

The dome was received at the USRL in January 1949. The Bureau of Ships, however, assigned to this particular project the lowest priority among five rather extensive projects then scheduled for the Bureau, so measurements were not begun until January 1950.

By this time, the Naval Research Laboratory had already reported:[2] "The severe distortion of the projector pattern as evidenced by the excessive widening of axial lobe and the high levels of the secondary and reflected lobes would make the dome unuseable. ... The dome may be acoustically suitable if used with equipment operating below 10 kc." It became evident fairly early in the USRL measurement program that these conclusions of NRL would be fully corroborated, a fact that was communicated to the Bureau of Ships informally and was given wider publicity in a paper presented at the Second Navy Underwater Acoustics Symposium.[3]

---

1. BuShips conf ltr C-S68-(9)(943) serial C-06618(943A) of 13 Sep 1948

2. NRL conf ltr report C-4000-268/49 (4014) he of 17 Oct 1949, "Interim Report on Sonar Dome Development - NRL Problem 40S07-04F - Acoustic Measurements of the 60-inch Edo Aircraft Company Lucite Dome"

3. H. W. Kompanek, "Dome Measurements at the USRL", paper presented at the Second Navy Underwater Acoustics Symposium, 7-8 Nov 1950

Following these reports, the Bureau of Ships informed the USRL by telephone that a report on the results was desired but that such a report could be informal, need not draw any conclusions, and that the submission of the report had no priority date. The data were therefore held without further analysis while more urgent projects were being completed. They are being presented here with somewhat less elaboration than is the USRL custom in order to bring this long-standing project to a formal close.

TRANSDUCER

The transducer used in the dome for these measurements is designated USRL type D1 serial 1, and is a modification of the BTL type QJB (CW 78207) transducer. The ADP-crystal array from the QJB is used in the D1 with an inertia drive in order to raise the resonant frequency to about 45 kc and thus extend the frequency range. The QJB case was modified slightly to provide the attachments necessary for rotator rigging with the dome.*

DOME

The dome is constructed of ¼-inch thick, optically clear lucite (methyl methacrylate) and is entirely free of any reinforcing struts or imbedded material. It is 60 inches long from bow to stern. The contour conforms to a hydrodynamic design established by the David Taylor Model Basin.[4]

MEASUREMENTS

The Bureau of Ships requested[1] "Sufficient data ... at 3, 15, 24, and 45 kilocycles to determine the transmission and receiving losses and beam distortion resulting when used with a transducer which can be trained and tilted."

All results presented in this report were made with the USRL type D1 transducer in the dome acting as a receiver.

---

*Because of high side lobes in the directivity pattern at 45 kc, this transducer is far from ideal for the purpose of dome measurements. It was the best instrument available at the time this project was in progress, however. A more suitable transducer has since been developed by the USRL Transducer Branch and will be the subject of a USRL report to be published in the near future.

4. Edo Aircraft Corporation Report No. 2593-2, Contract NObsr-42120, "Interim Engineering Report on Sonar Domes" (CONFIDENTIAL)

Measurements were made at a wide variety of orientations of dome and transducer, which are specified in the Figures in terms of azimuth and tilt angles. Directivity patterns are labelled either "Horizontal" or "Vertical". These terms are explained with the aid of a sketch in Fig. 1.

Directivity patterns presented are of three types, defined as follows:*

Dome Field Pattern - the dome is locked to the transducer at a fixed relative orientation, and both are rotated together.

Dome Beam Pattern - the dome is locked at a fixed orientation relative to the transducer axis, and the transducer only is rotated.

Dome Rotation Pattern - the transducer axis is aligned with the axis of the source, and the dome only is rotated. This type of pattern gives a measurement of transmission loss through the dome wall.

RESULTS

Dome Loss Measurements - Dome loss measurements as a function of frequency and azimuth angle (0° tilt) are shown in Fig. 2. These measurements were made with the D1 transducer in the dome receiving and show the loss at various dome azimuth angles relative to the "no dome" condition.

Additional measurements of dome loss are shown in the form of dome rotation patterns in Fig. 3. These patterns represent loss at various azimuth angles relative to the loss at zero azimuth.**

Beam Distortion, Specular and Scattered Reflections - The effect of the dome in distorting the main beam and introducing specular and scattered reflections can be seen by comparing the patterns for the transducer alone ("Control Patterns") shown in Fig. 4 to the dome field patterns in Figs. 5 through 26, and to the dome beam patterns in Fig. 27.

CONCLUSIONS

No detailed analysis of the patterns presented in this report has been prepared for the reasons set forth in the Introduction; however, none seems

---

*These definitions conform to those used by the Naval Research Laboratory in the letter report previously cited.

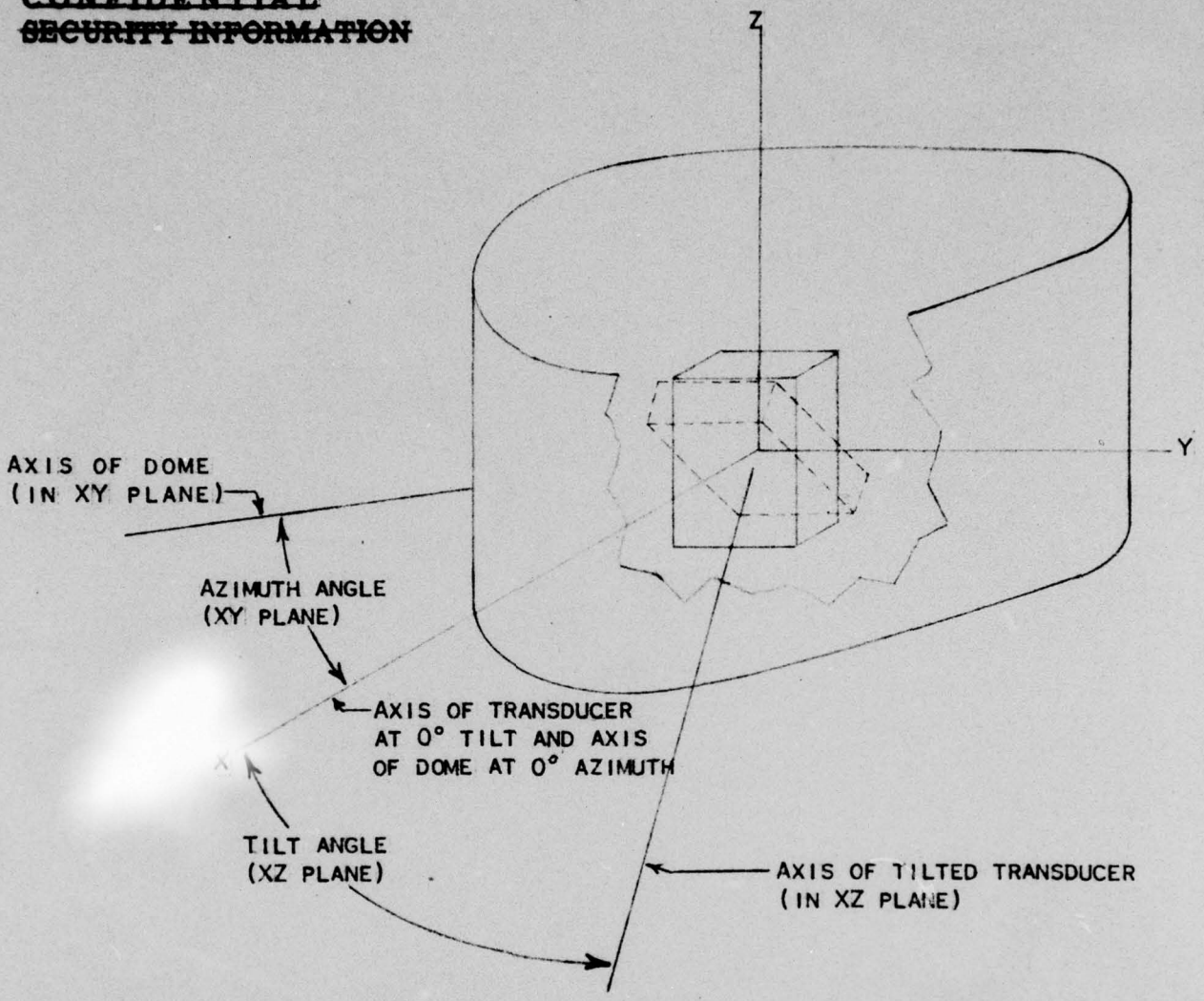
**Some slight discrepancies between the results shown in Fig. 2 and those shown in Fig. 3 are apparent when the two are compared. Experimental error in acoustic measurements, plus a slight misorientation of the dome between the two series of measurements account for the differences.

necessary to support the conclusion that the dome is acoustically unsuitable for sonar use except at the relatively low frequencies, as previously stated by the Naval Research Laboratory.

A casual examination of the patterns is sufficient to reveal the large number of unusually high specular reflections, some of which are only 2 or 3 db down from the main beam.* Where the main beam is incident on the dome at or near the "critical angle" for lucite (37°), a bifurcated main beam results. In these connections, see particularly azimuth angle 135° in Fig. 6, 135° in Fig. 7, and 30° and 135° in Fig. 8. Such features are clearly intolerable in a dome intended for use with sonar equipment.

---

*All patterns at 45 kc must be interpreted with the high side lobes of the transducer in mind.



The dome and transducer may be placed at the origin of a cartesian coordinate system as shown.

The *azimuth angle* is adjusted by rotating the dome about the Z axis and is defined as the angle between the X axis and the axis of the dome.

The *tilt angle* is adjusted by rotating the transducer about the Y axis and is defined as the angle between the X axis and the axis of the transducer.

Patterns labelled *Horizontal* lie in the XY plane and were made by rotating about the Z axis.

Patterns labelled *Vertical* lie in the XZ plane and were made by rotating about the Y axis.

Fig. 1. Orientation of dome and transducer

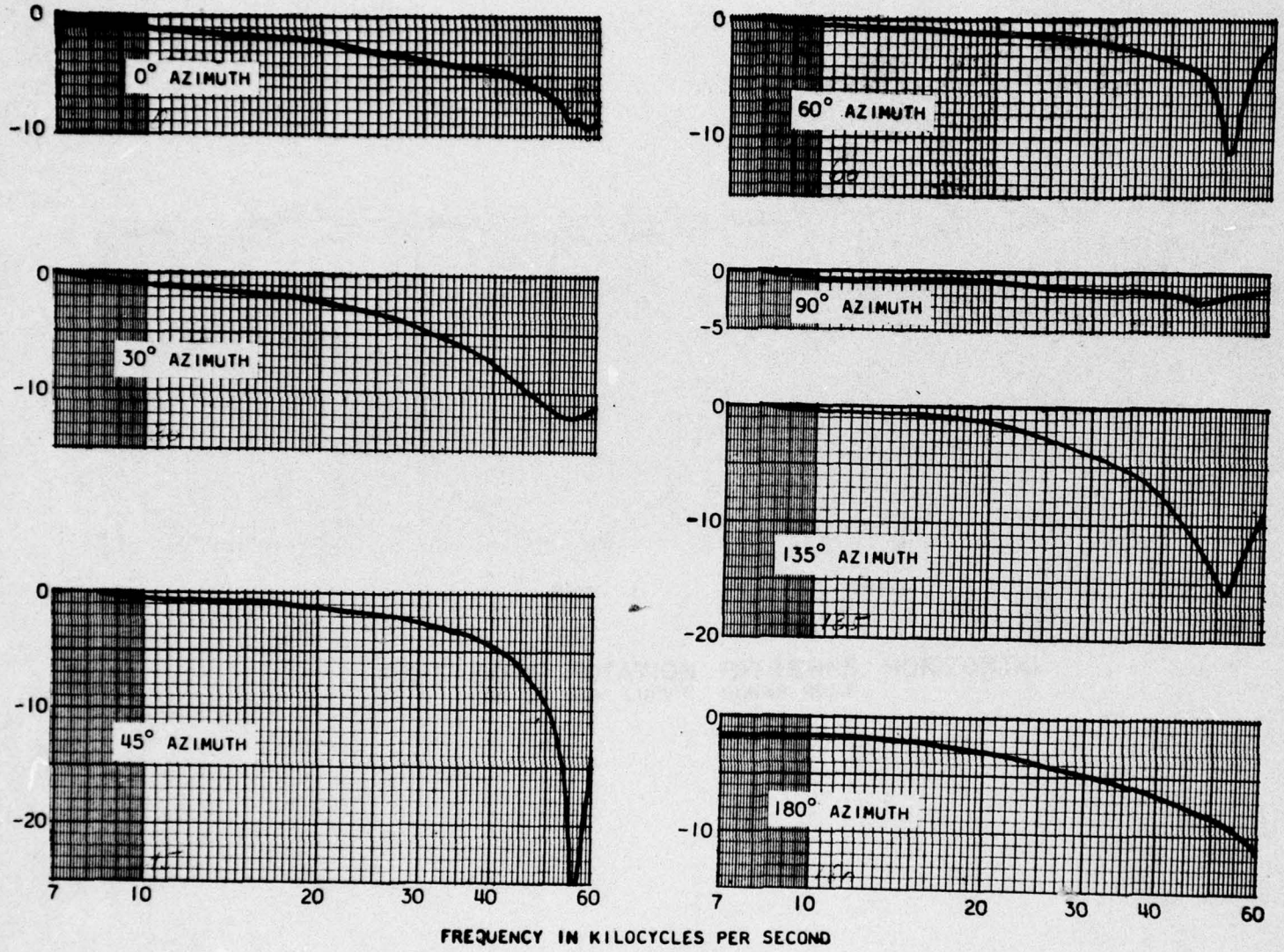


FIG. 2 TRANSMISSION LOSS OF EDO 60-INCH LUCITE SONAR DOME AS A FUNCTION OF FREQUENCY AND AZIMUTH ANGLE

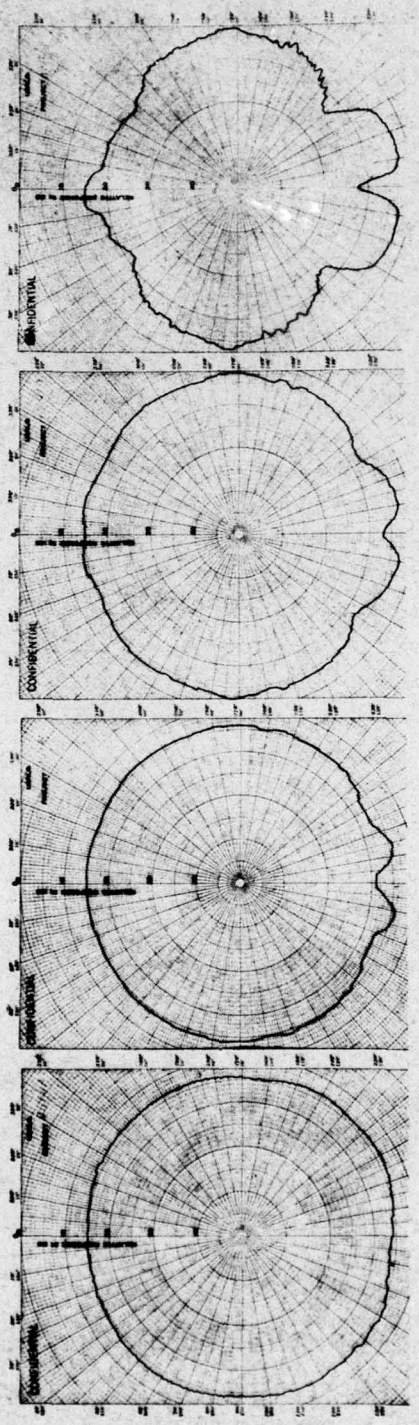


FIG. 3 DOME ROTATION PATTERNS, HORIZONTAL
EDO 60-INCH LUCITE SONAR DOME

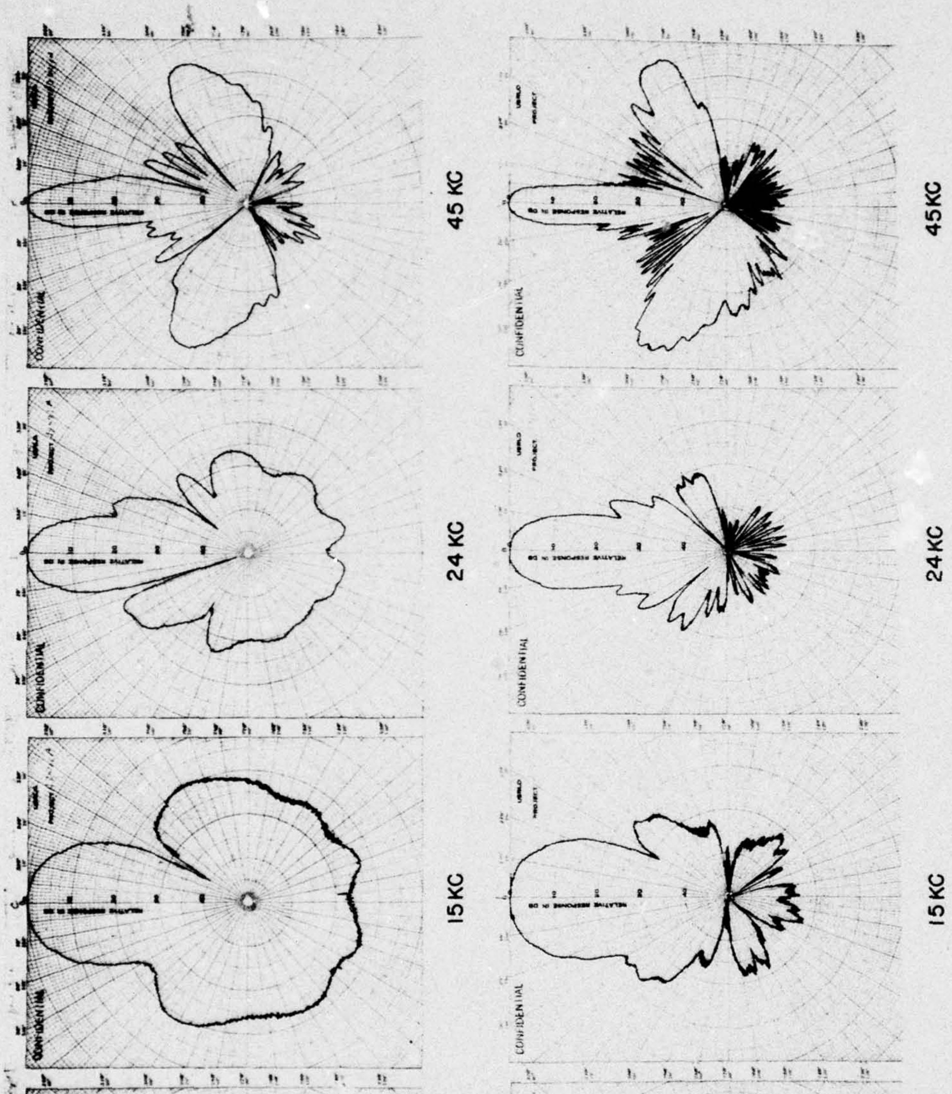


FIG. 4 CONTROL PATTERNS
DIRECTIVITY OF DI TRANSDUCER NO. I ALONE

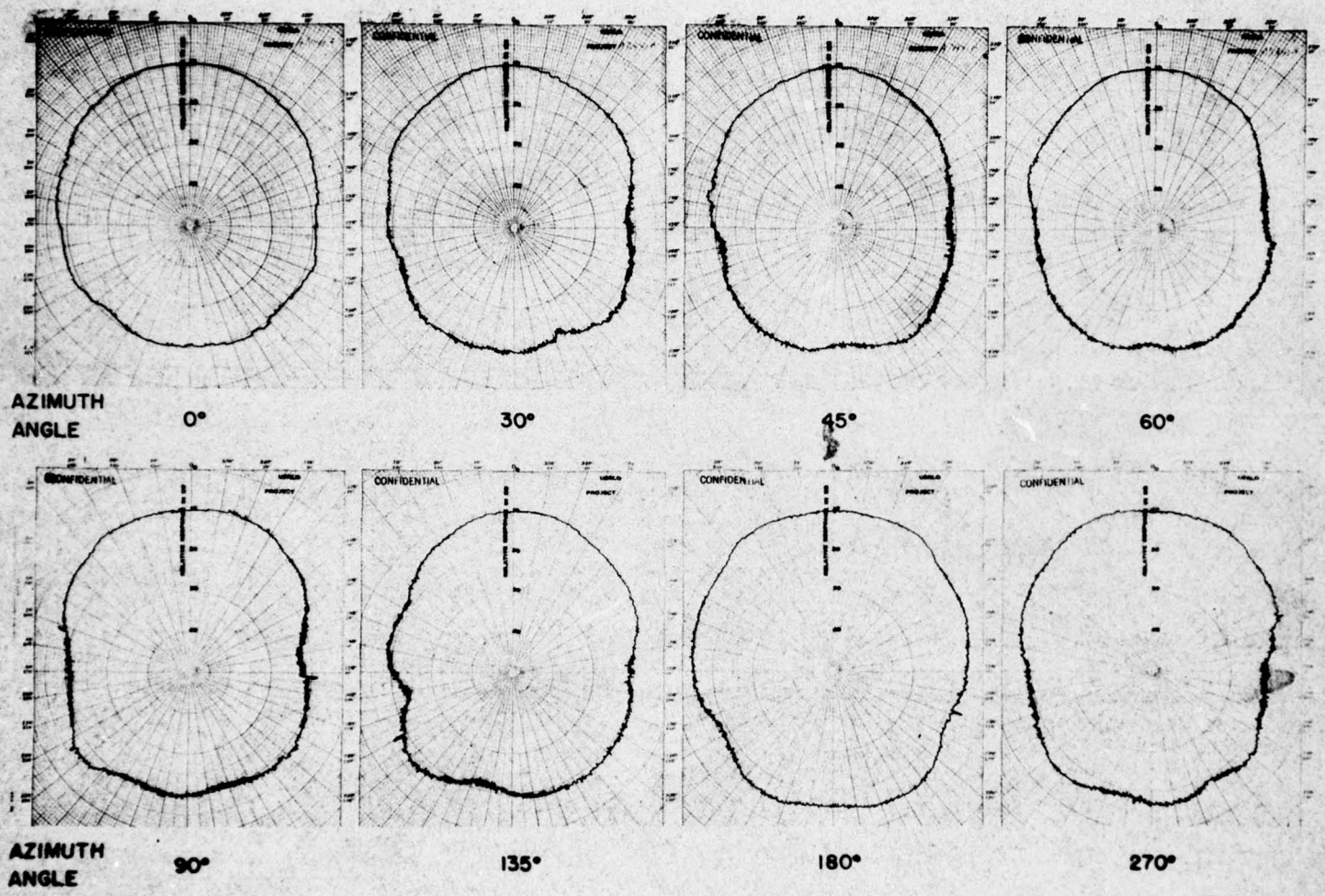


FIG. 5 DOME FIELD PATTERN, HORIZONTAL, 3 KC
EDO 60-INCH LUCITE SONAR DOME

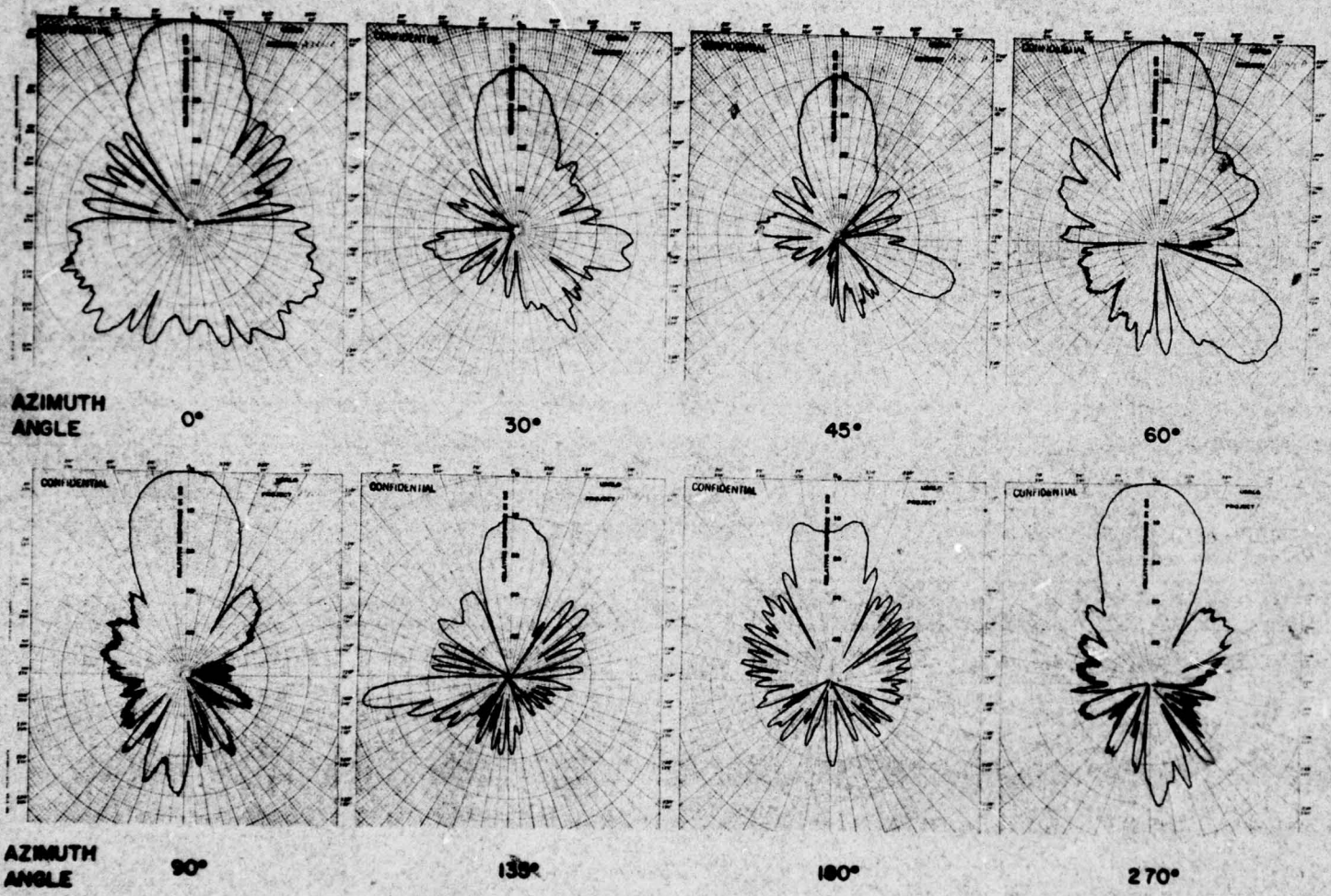
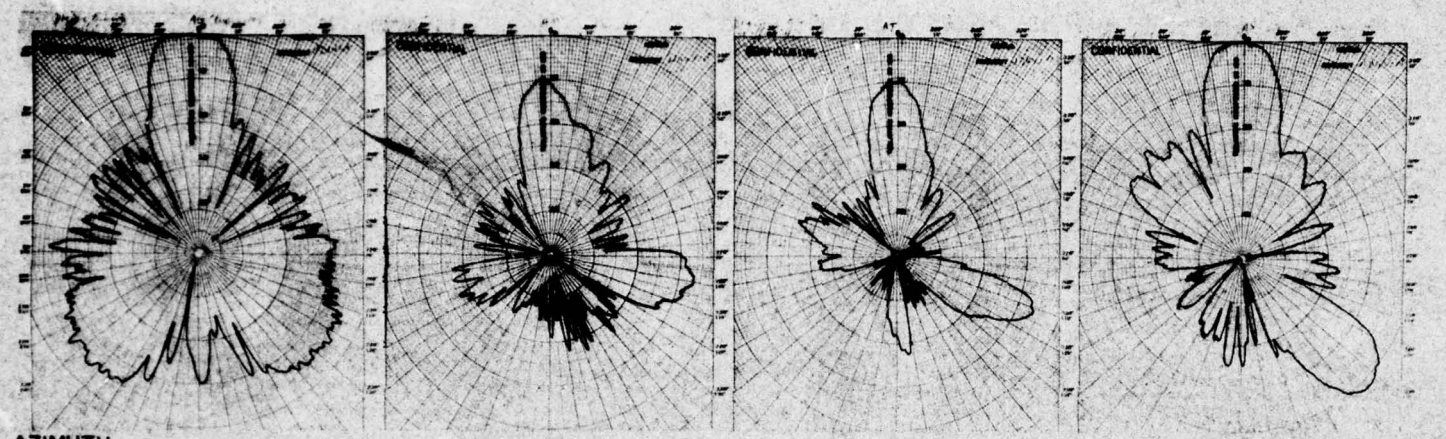


FIG. 6 DOME FIELD PATTERNS, HORIZONTAL, 15 KC
EDO 60-INCH LUCITE SONAR DOME



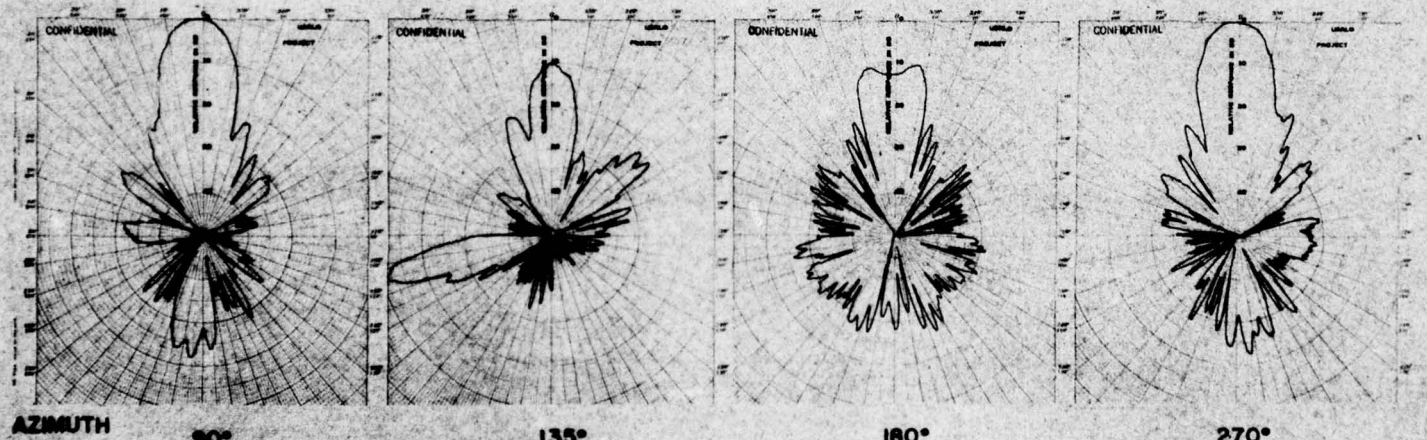


FIG. 7 DOME FIELD PATTERNS, HORIZONTAL, 24 KC
EDO 60-INCH LUCITE SONAR DOME

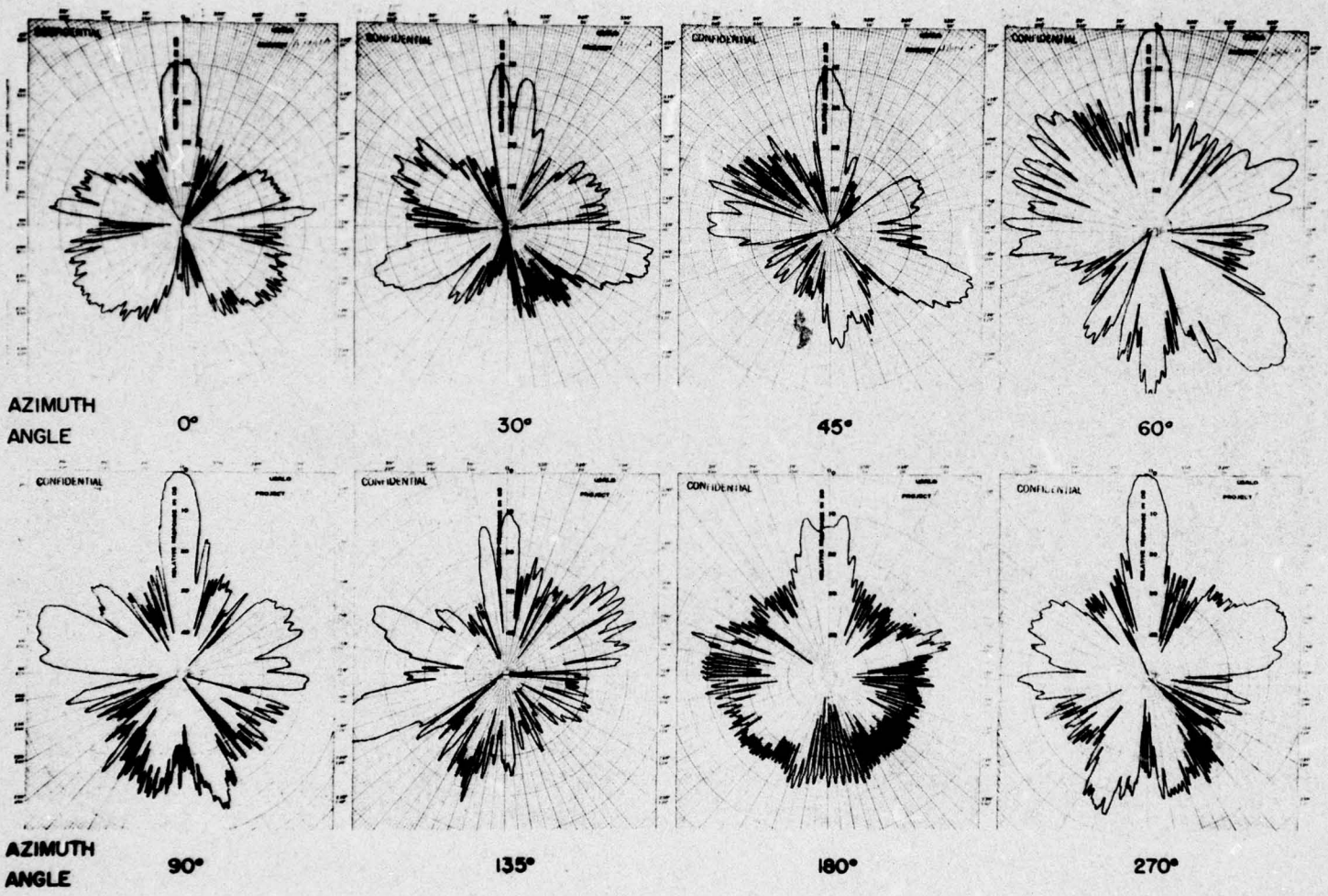


FIG. 8 DOME FIELD PATTERNS, HORIZONTAL, 45 KC
EDO 60-INCH LUCITE SONAR DOME

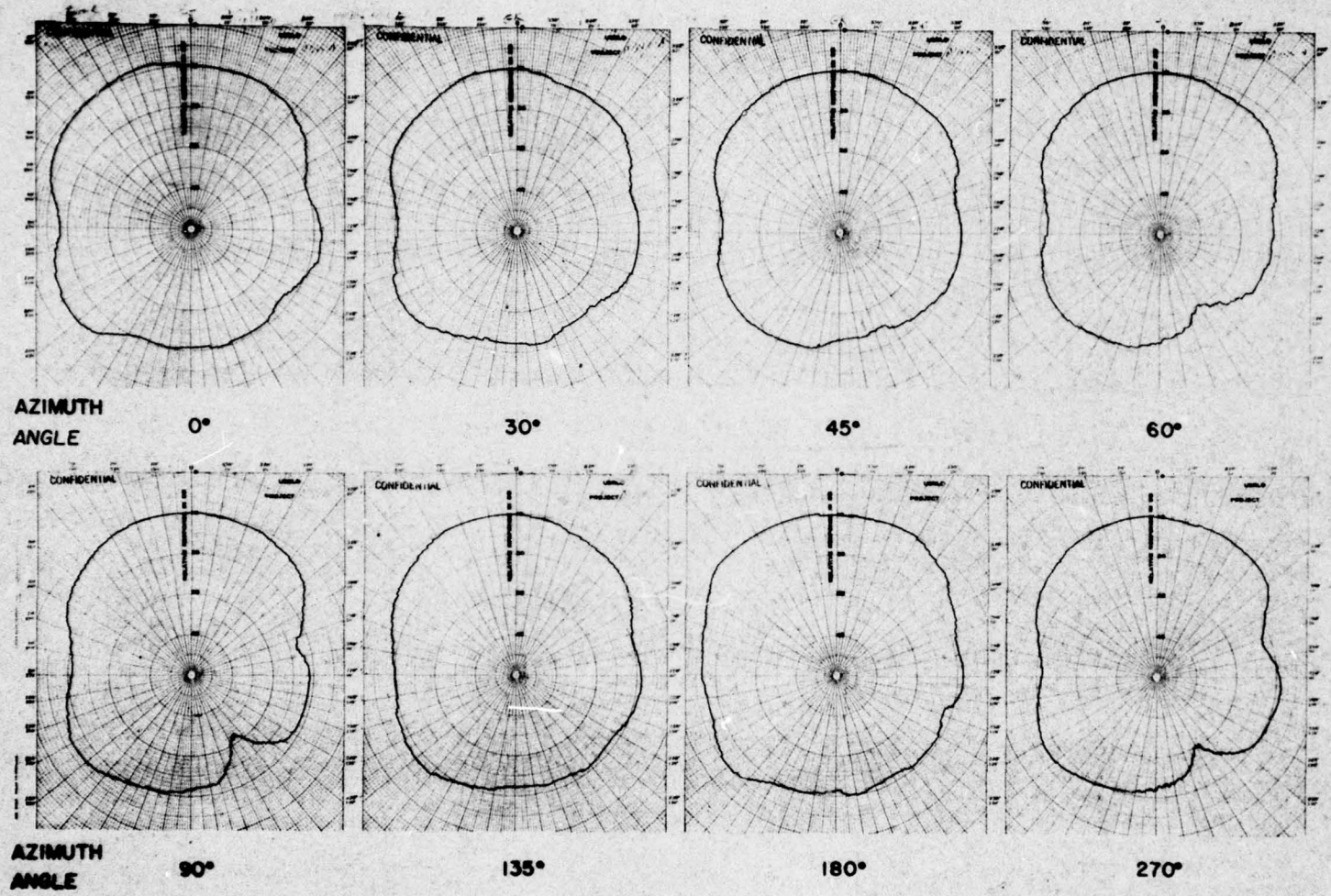


FIG. 9 DOME FIELD PATTERNS, VERTICAL, 3 KC, 0° TILT
EDO 60-INCH LUCITE SONAR DOME

~~CONFIDENTIAL~~

~~SECURITY INFORMATION~~

USRL PROJECT NO. AD-441

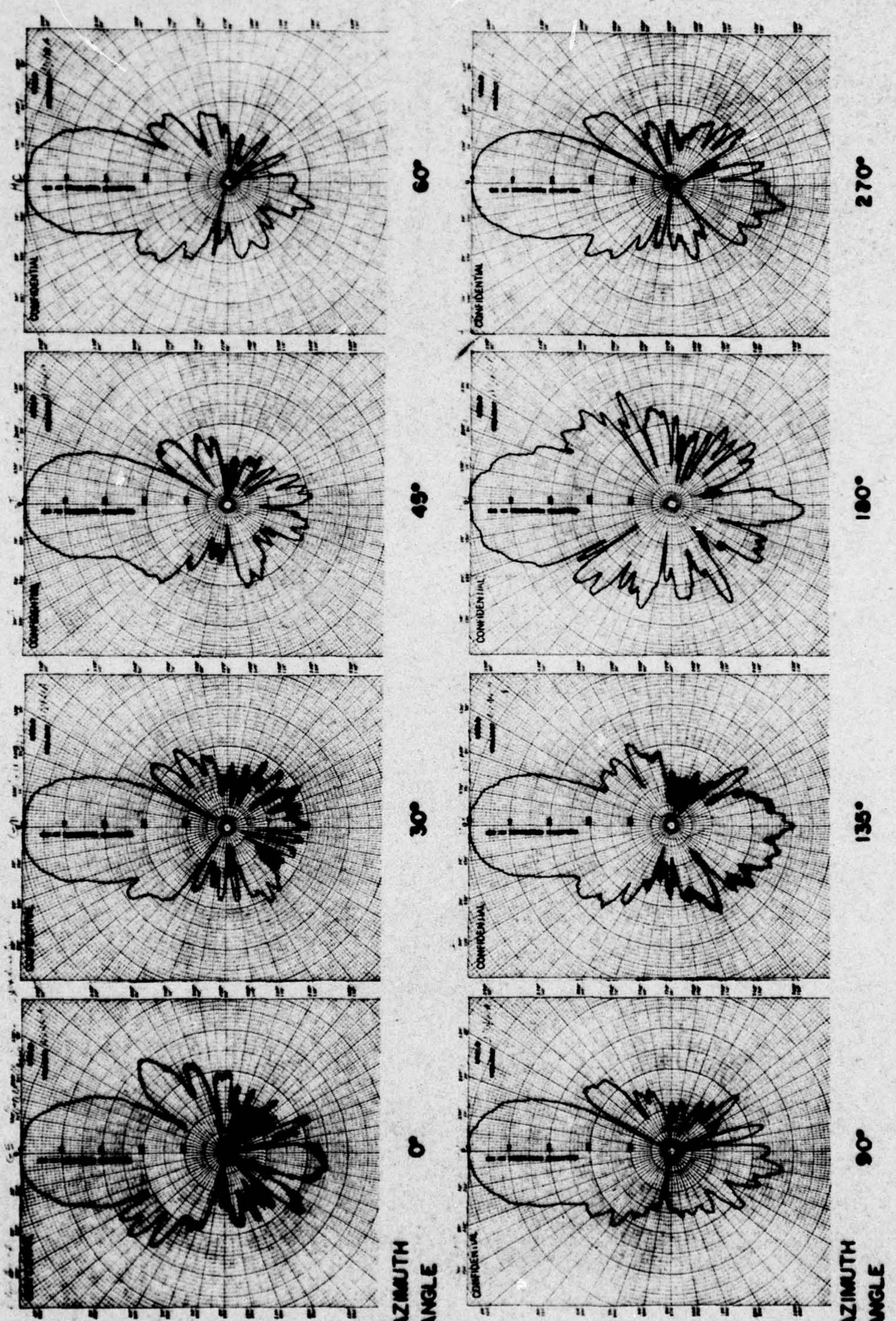


FIG. 10 DOME FIELD PATTERNS, VERTICAL, 15 KC, 0° TILT
EDO 60-INCH LUCITE SONAR DOME

~~CONFIDENTIAL~~

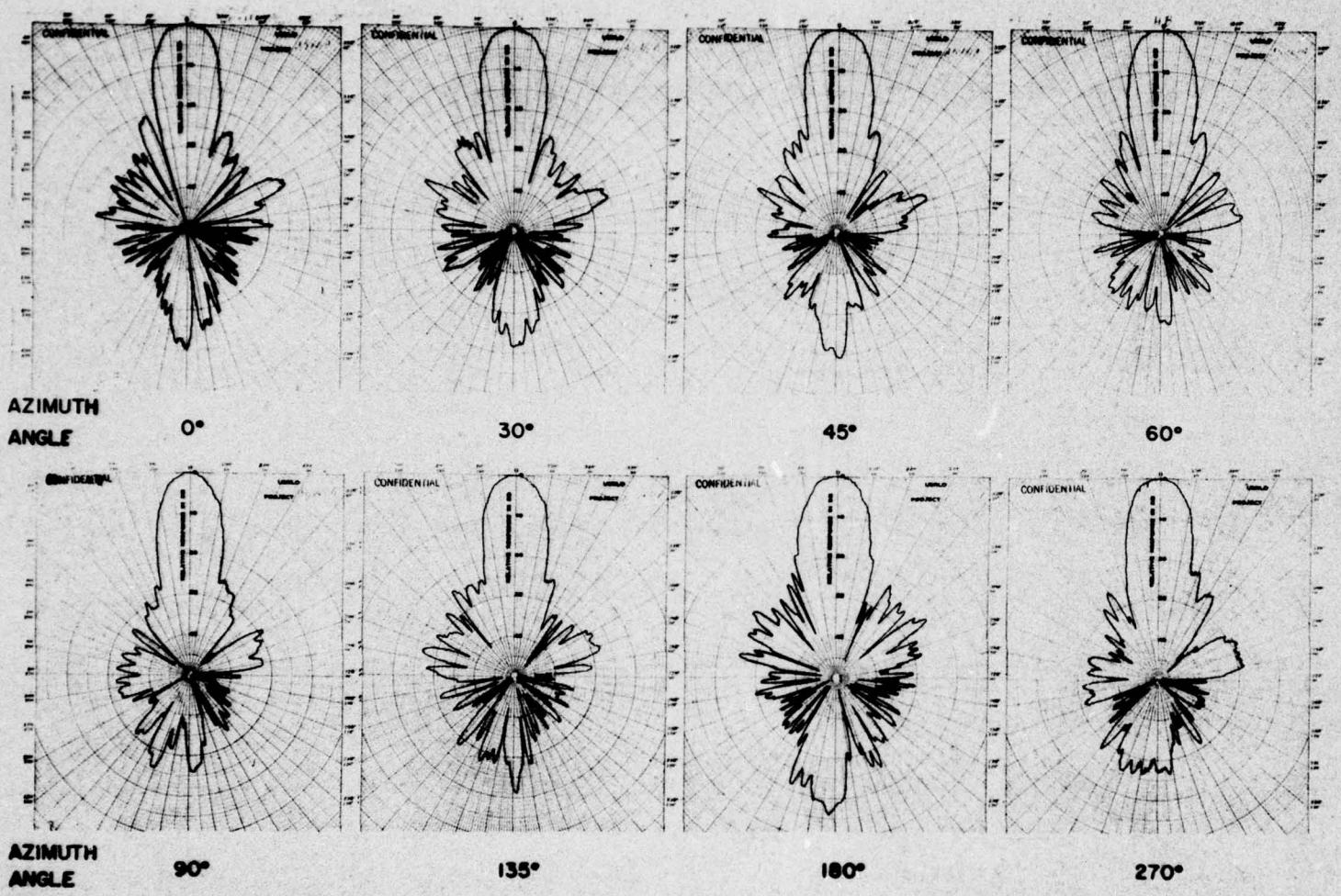


FIG. 11 DOME FIELD PATTERNS, VERTICAL, 24KC, 0° TILT
EDO 60-INCH LUCITE SONAR DOME

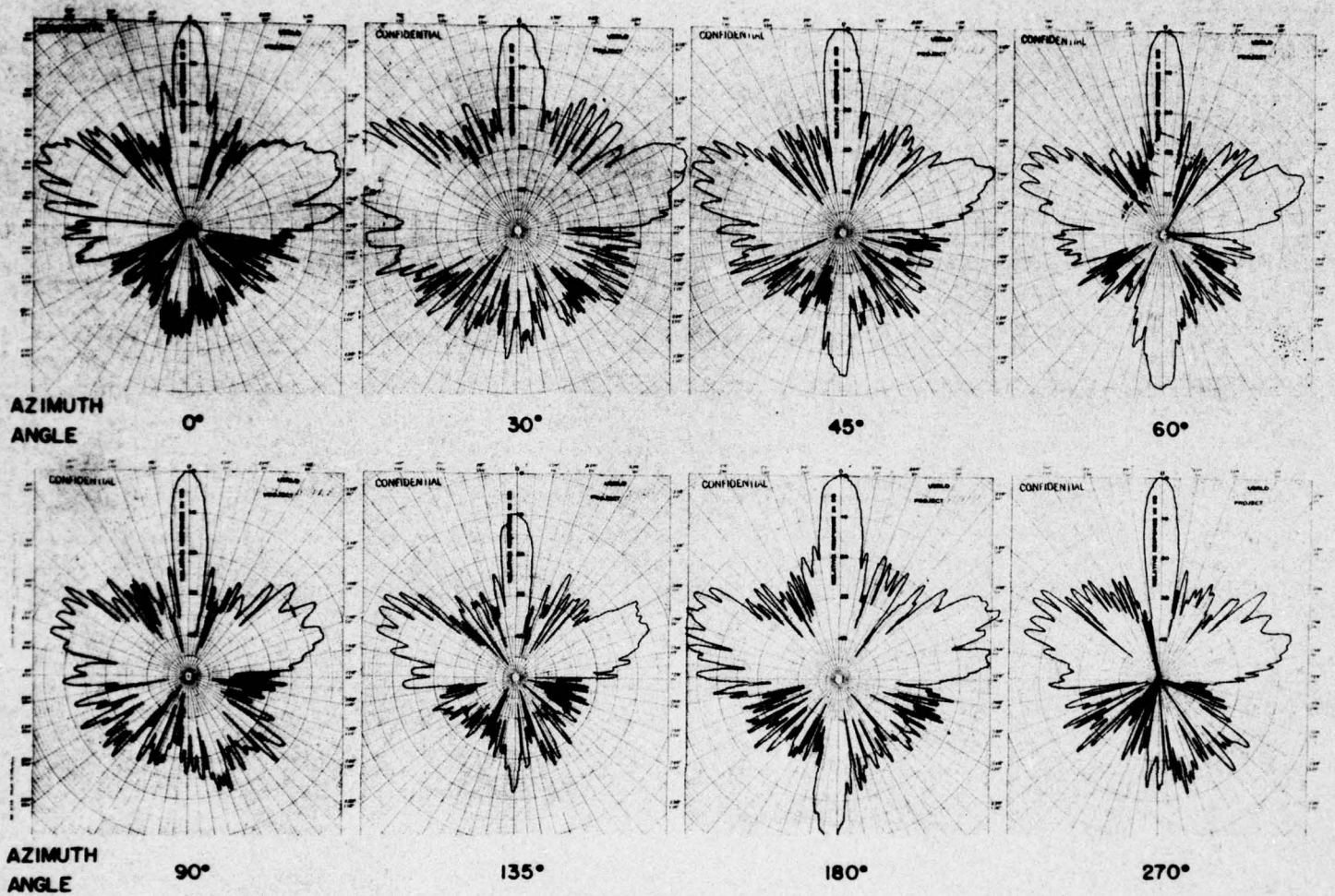


FIG. 12 DOME FIELD PATTERNS, VERTICAL, 45 KC, 0° TILT
EDO 60-INCH LUCITE SONAR DOME

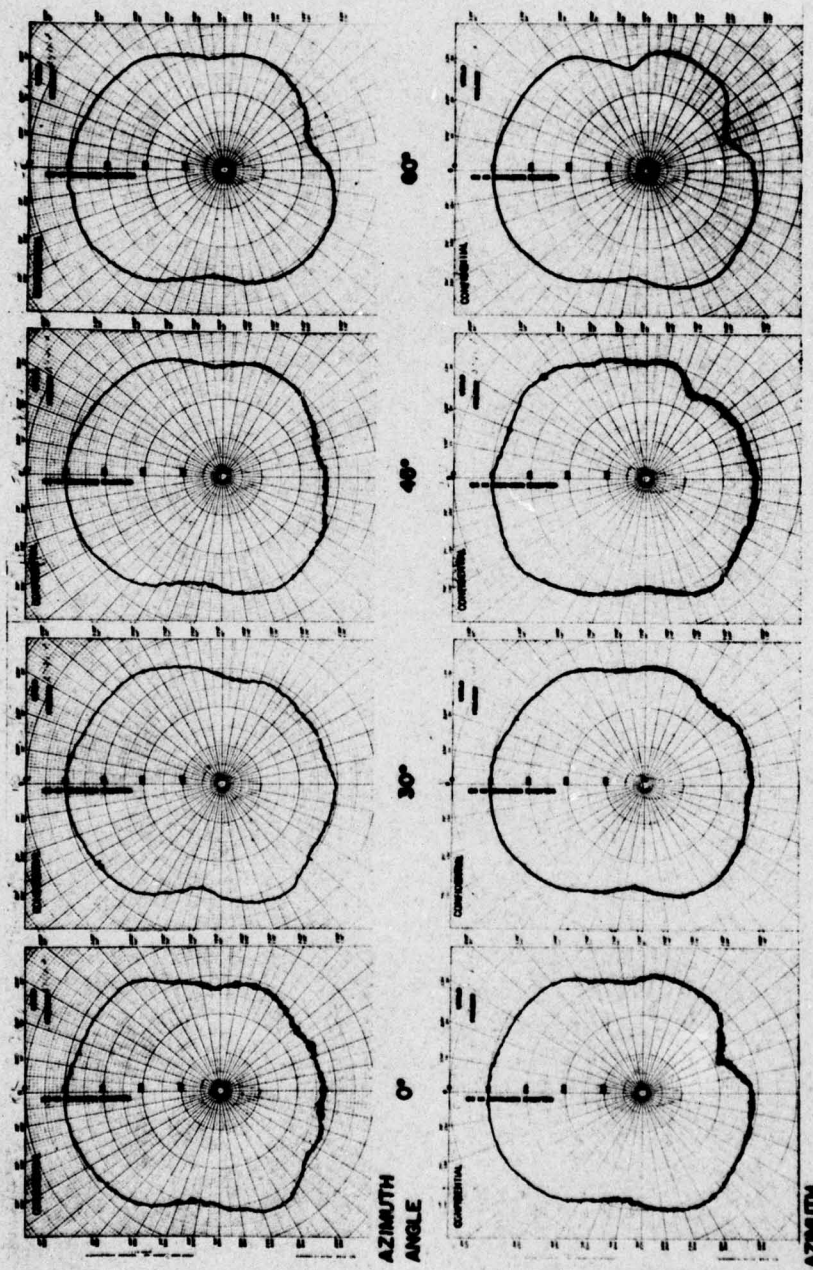


FIG. 13 DOME FIELD PATTERNS, VERTICAL, 3 KC, 10° TILT
EDO 60-INCH LUCITE SONAR DOME

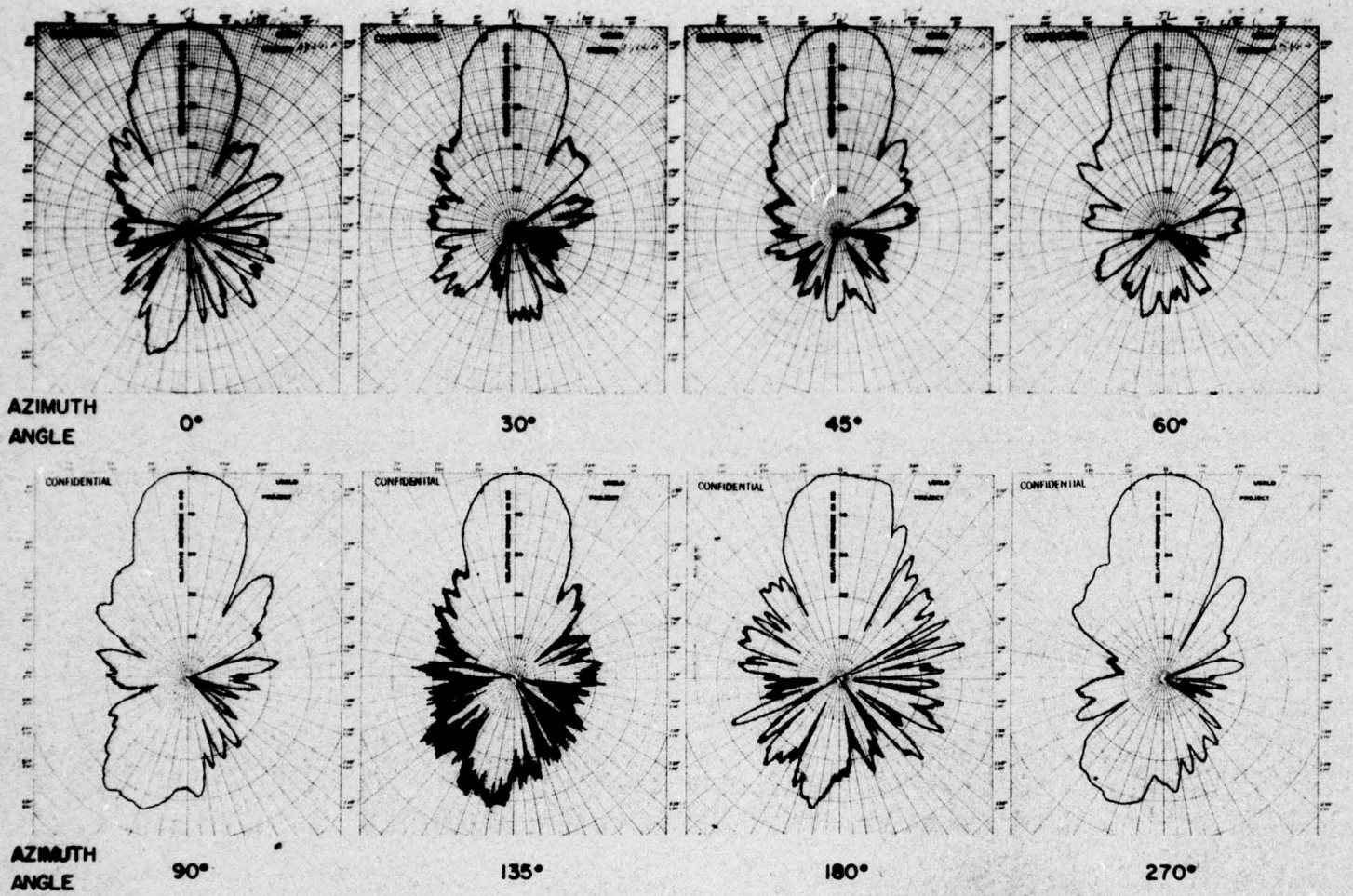


FIG. 14 DOME FIELD PATTERNS, VERTICAL, 15 KC, 10° TILT
EDO 60-INCH LUCITE SONAR DOME

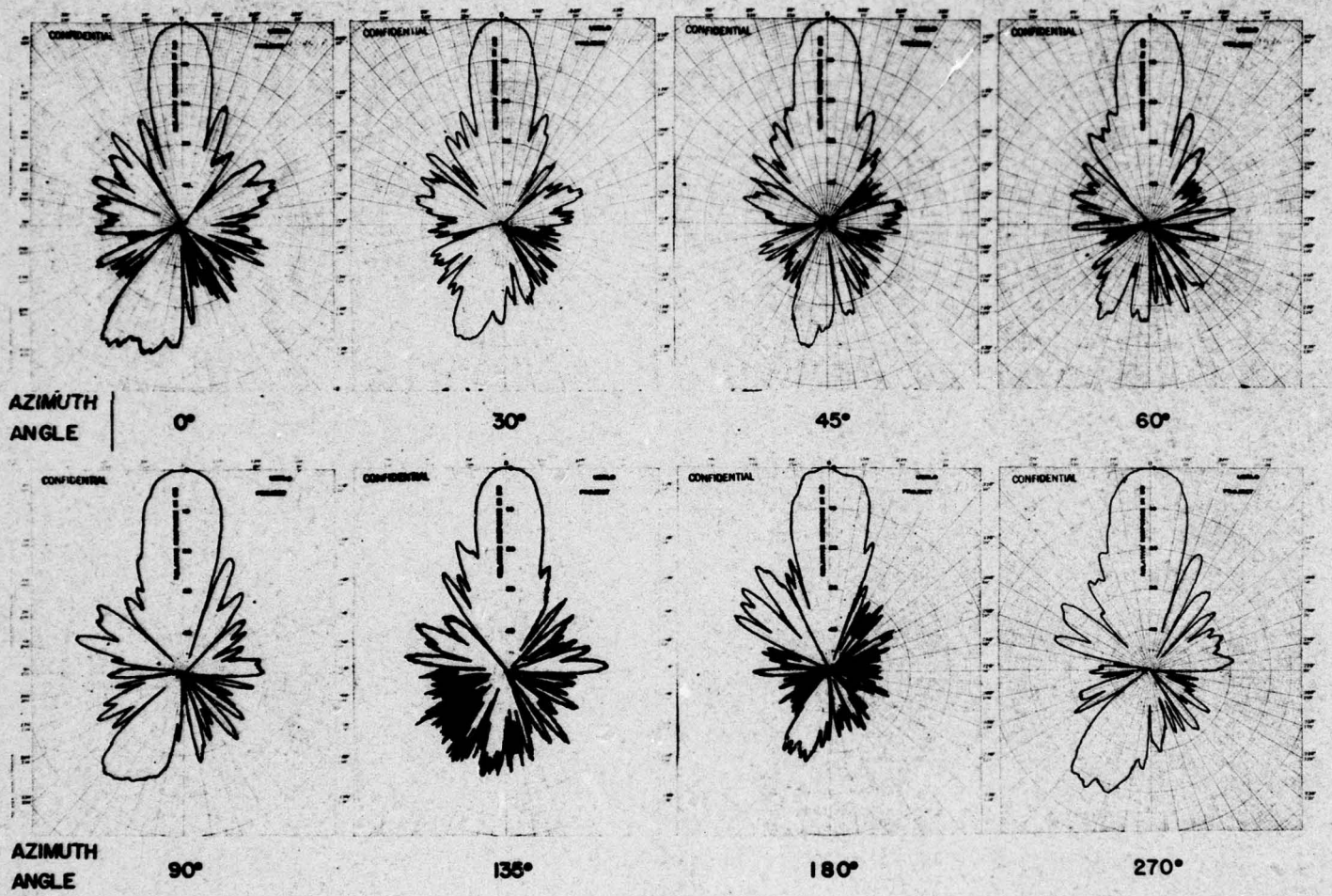


FIG. 15 DOME FIELD PATTERNS, VERTICAL, 24 KC, 10° TILT
EDO 60-INCH LUCITE SONAR DOME

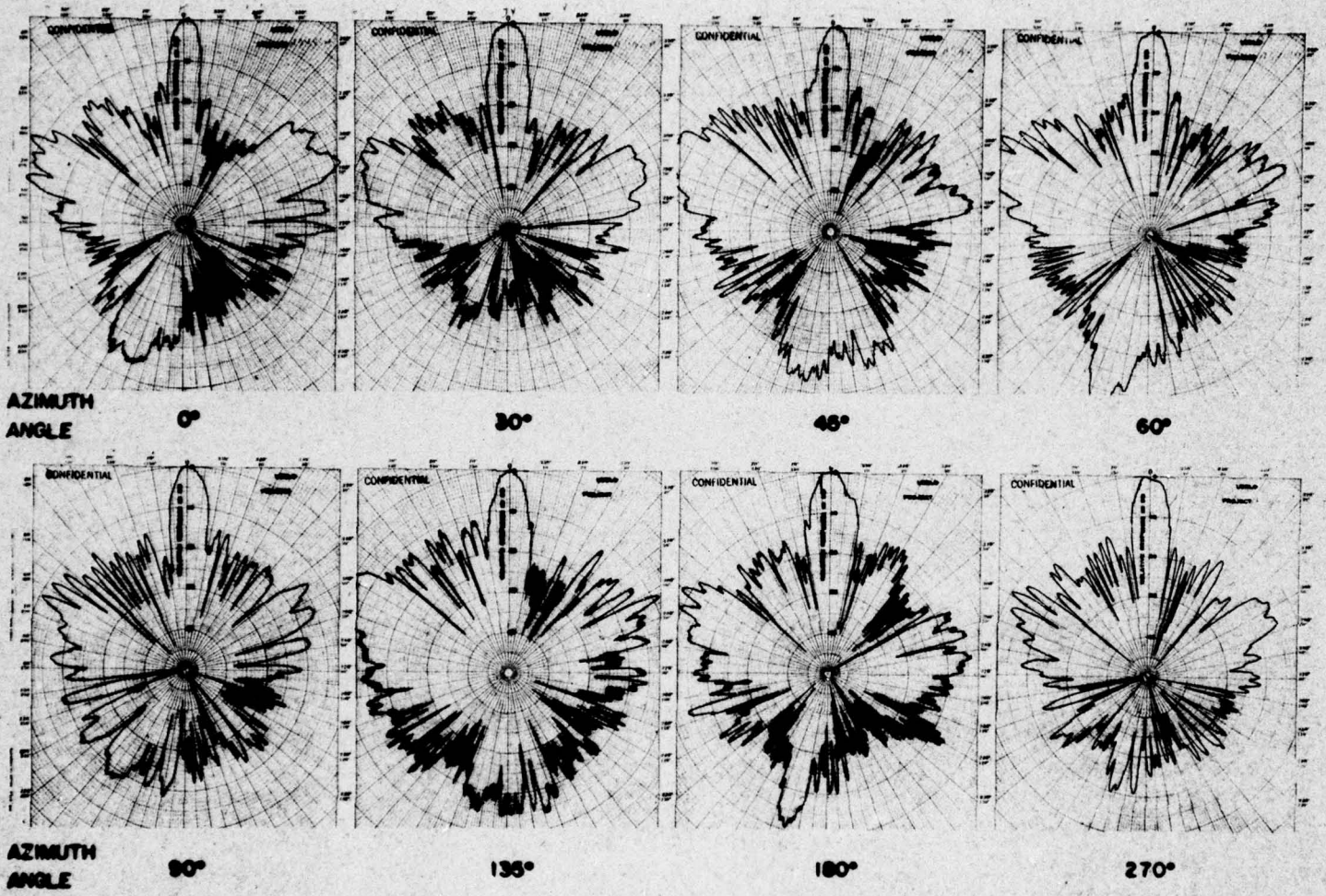


FIG. 16 DOME FIELD PATTERNS, VERTICAL, 45 KC, 10° TILT
EDO 60-INCH LUCITE SONAR DOME

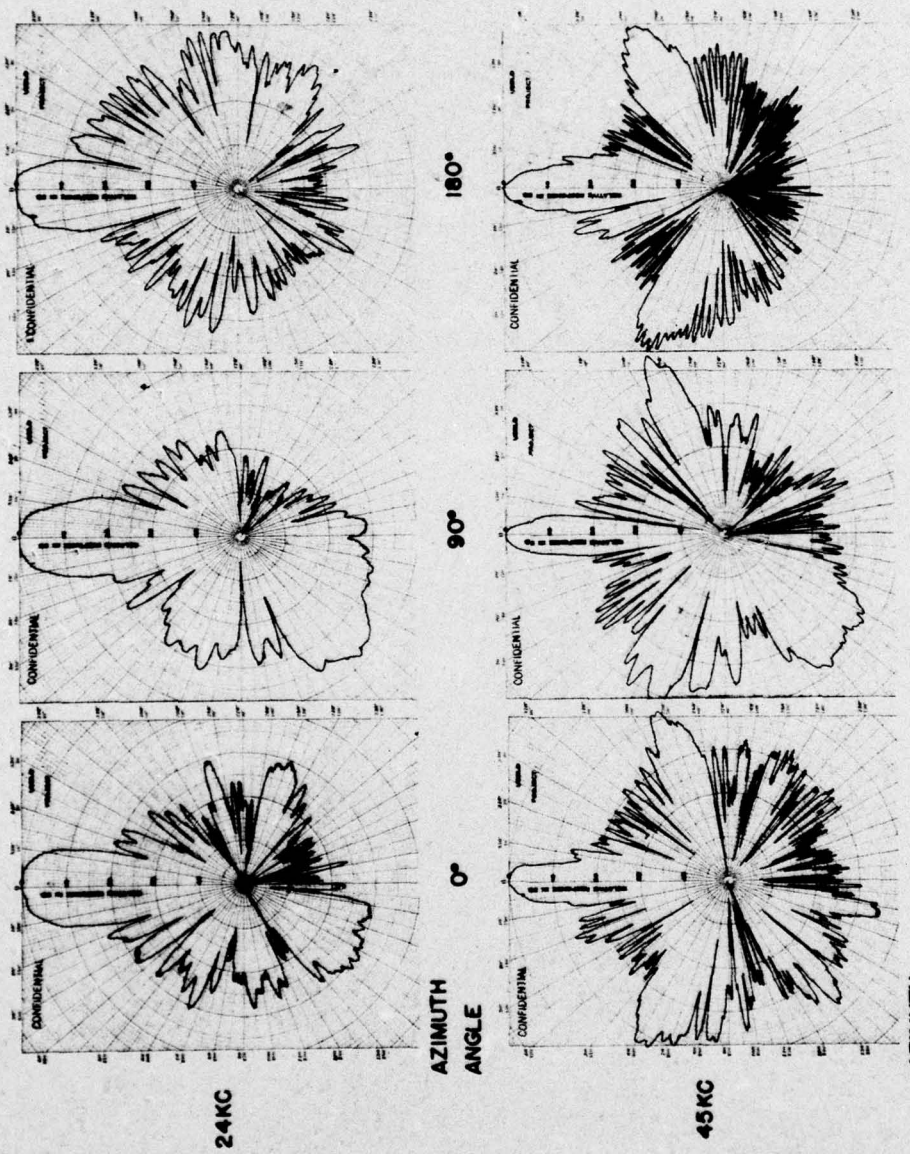


FIG. 17 DOME FIELD PATTERNS, VERTICAL, 24 AND 45 KC, 20° TILT
EDO 60-INCH LUCITE SONAR DOME

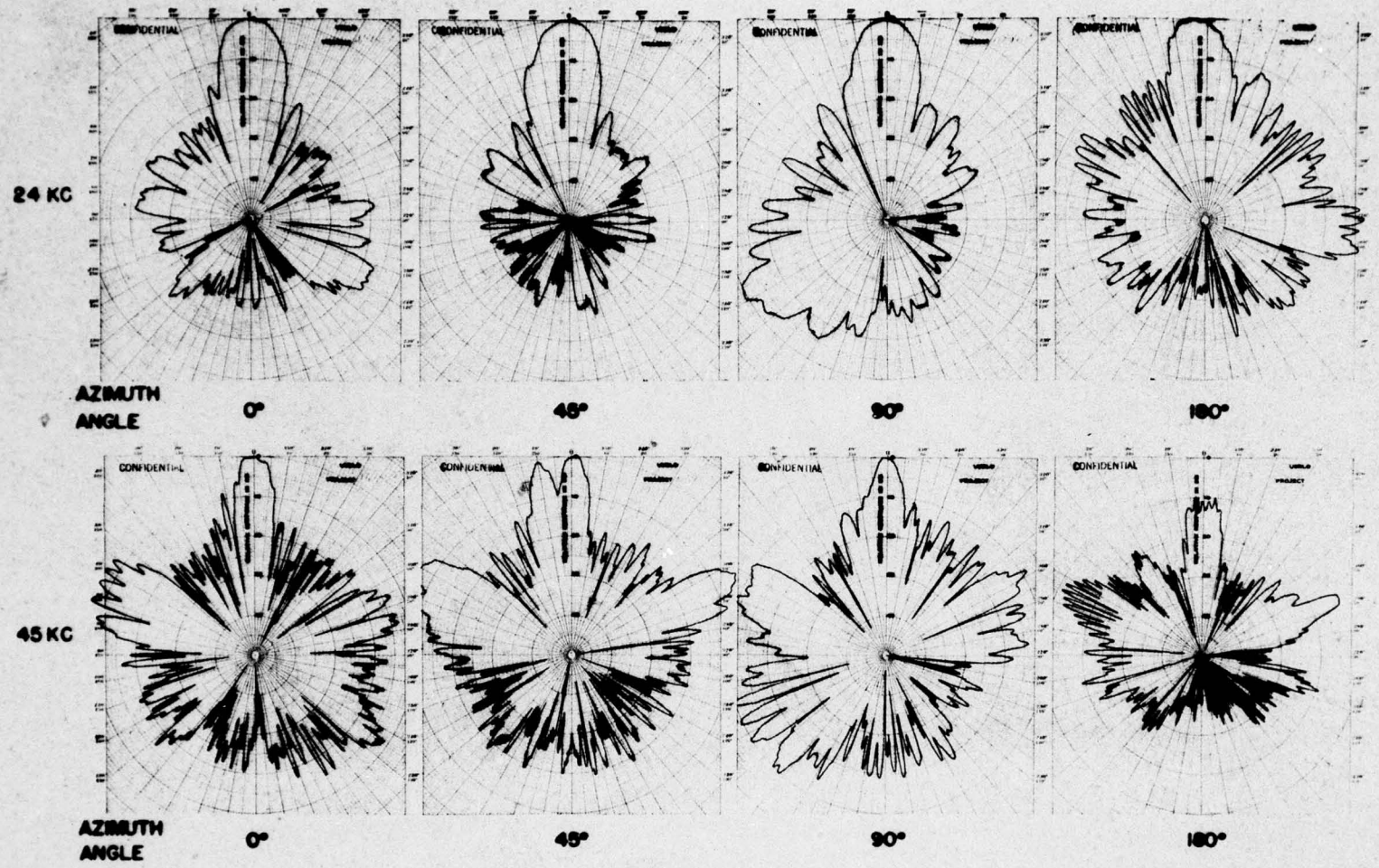


FIG. 18 DOME FIELD PATTERNS, VERTICAL, 24 AND 45 KC, 30° TILT
EDO 60-INCH LUCITE SONAR DOME

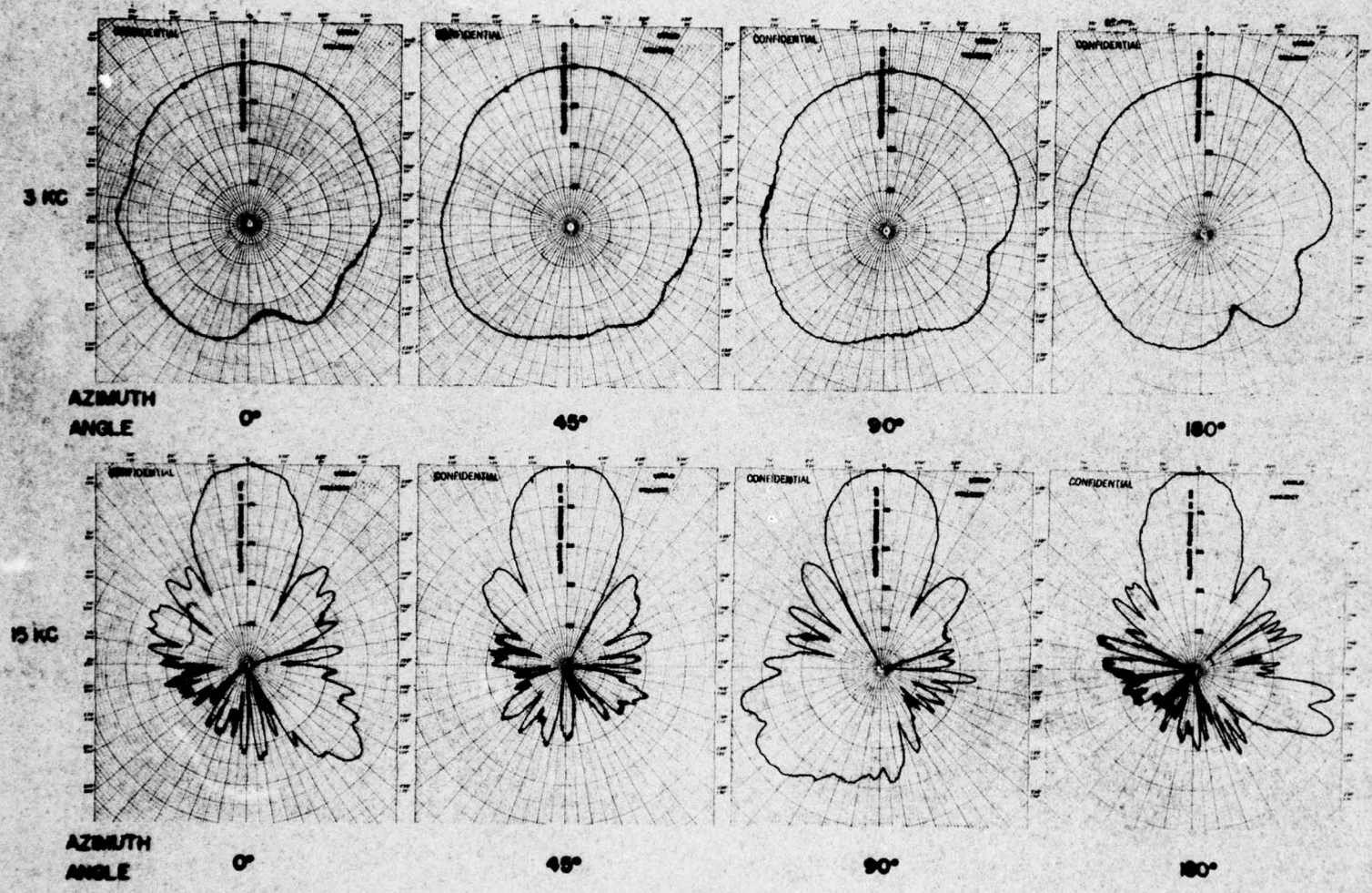


FIG. 19 DOME FIELD PATTERNS, VERTICAL, 3 AND 15 KC, 45° TILT
EDO 60-INCH LUCITE SONAR DOME

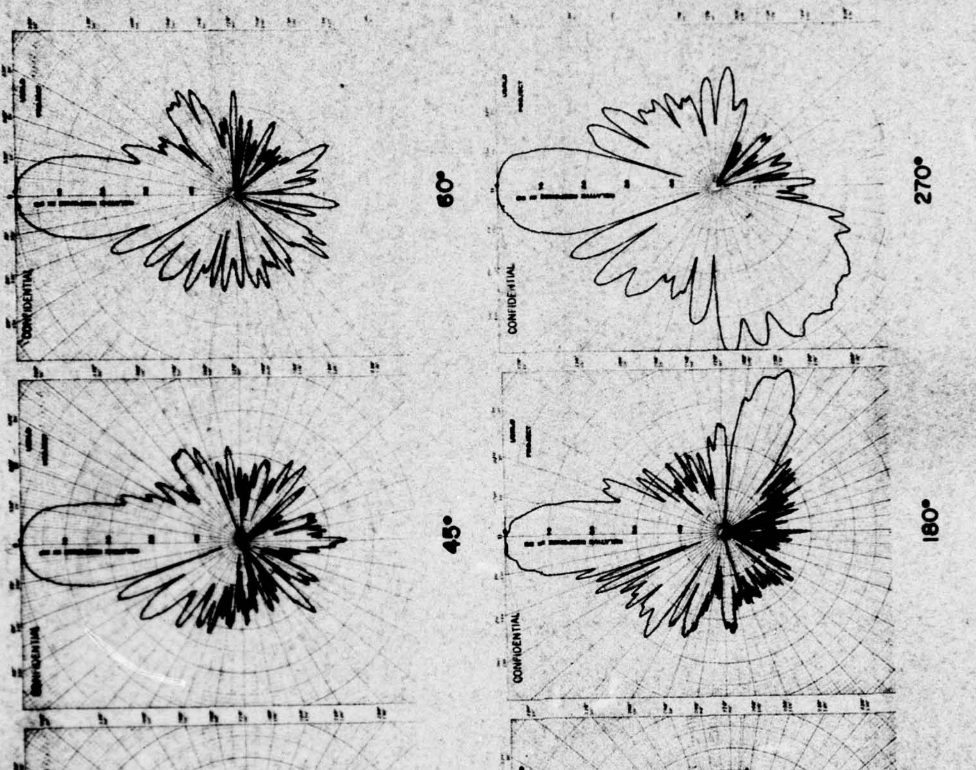


FIG. 20 DOME FIELD PATTERNS, VERTICAL, 24KC, 45° TILT
EDO 60-INCH LUCITE SONAR DOME

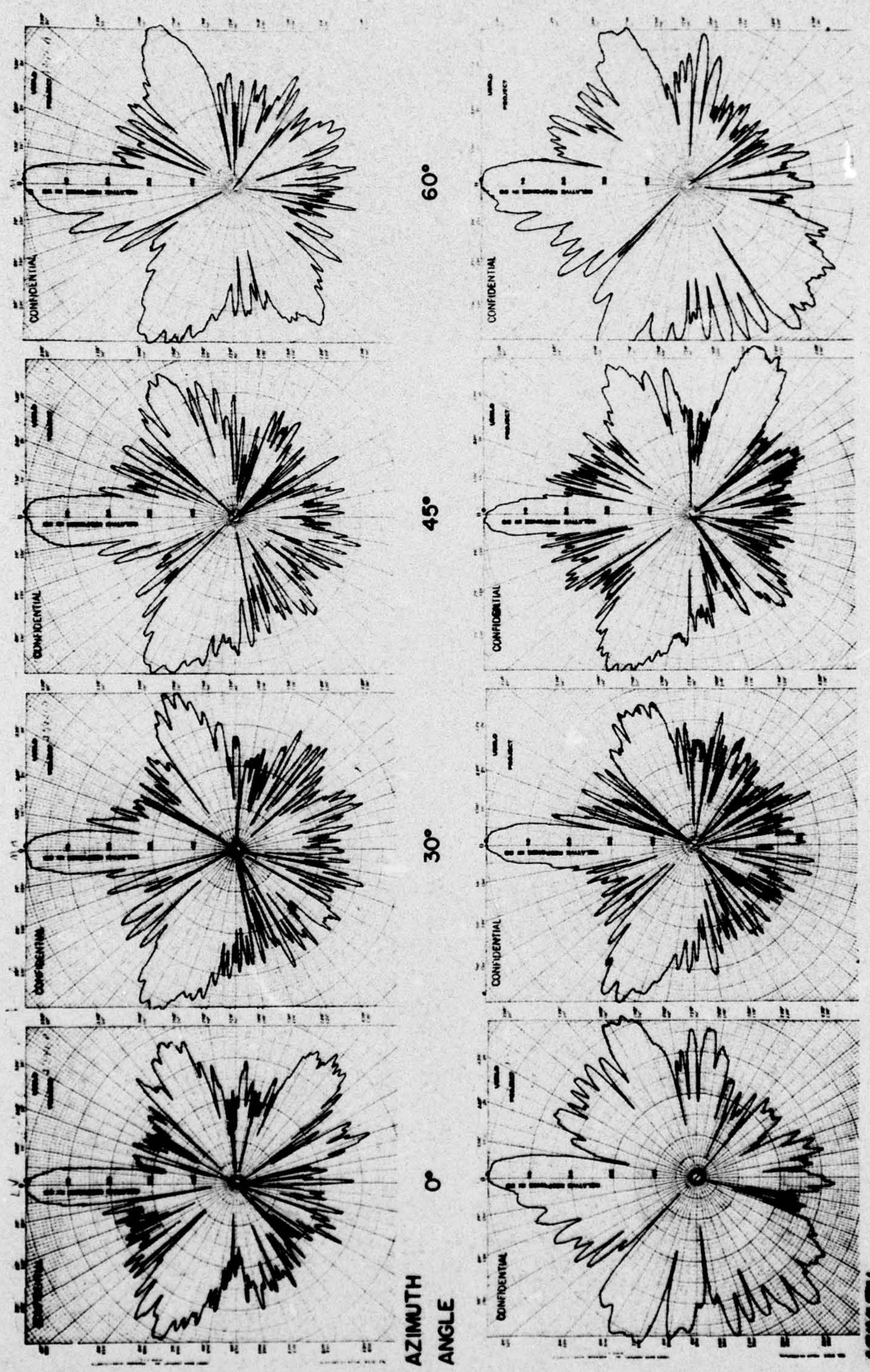


FIG. 21 DOME FIELD PATTERNS, VERTICAL, 45 KC, 45° TILT
EDO 60-INCH LUCITE SONAR DOME

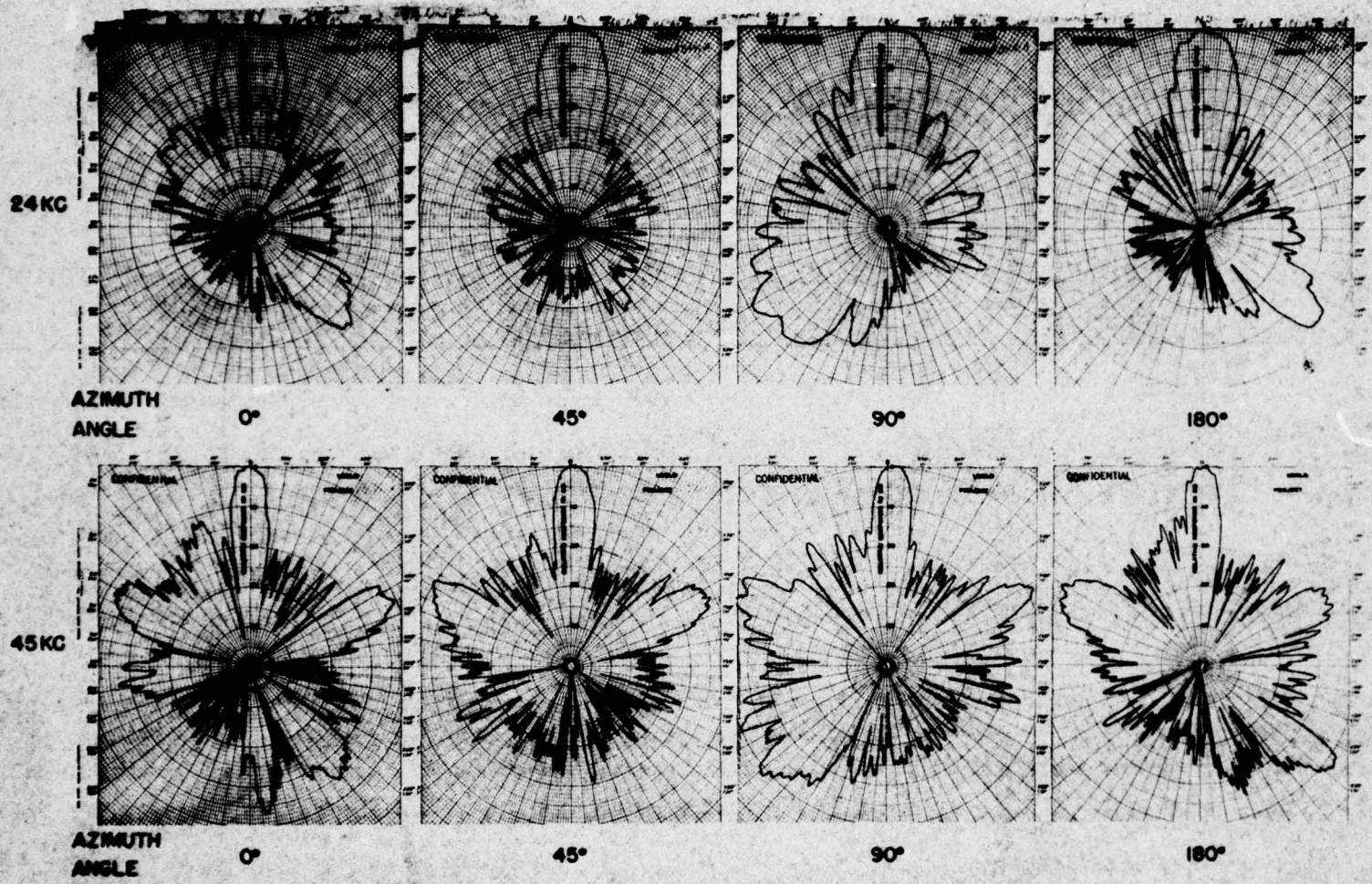


FIG. 22 DOME FIELD PATTERNS, VERTICAL, 24 AND 45 KC, 60° TILT
EDO 60-INCH LUCITE SONAR DOME

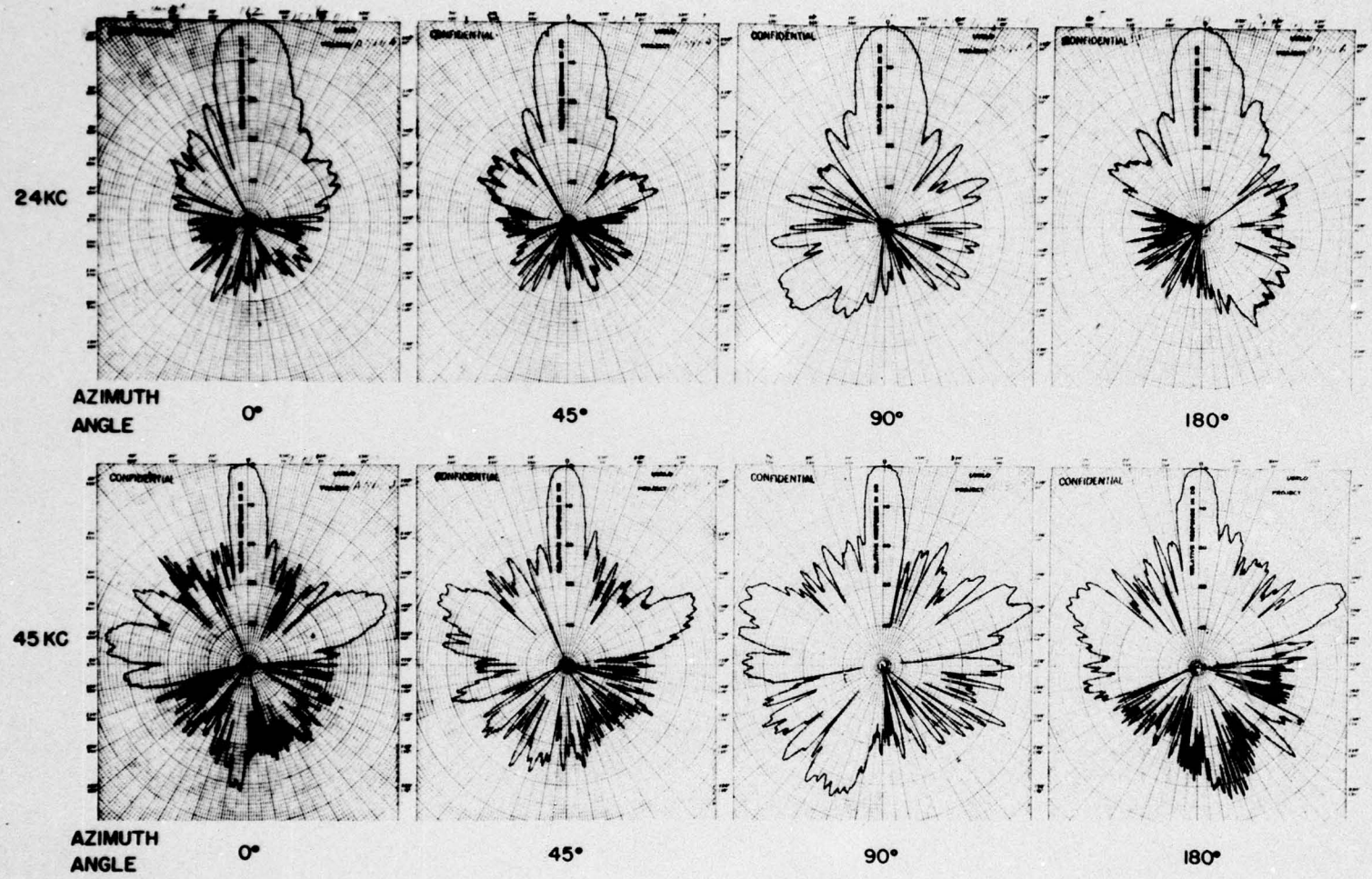


FIG. 23 DOME FIELD PATTERNS, VERTICAL, 24 AND 45 KC, 75° TILT
EDO 60-INCH LUCITE SONAR DOME

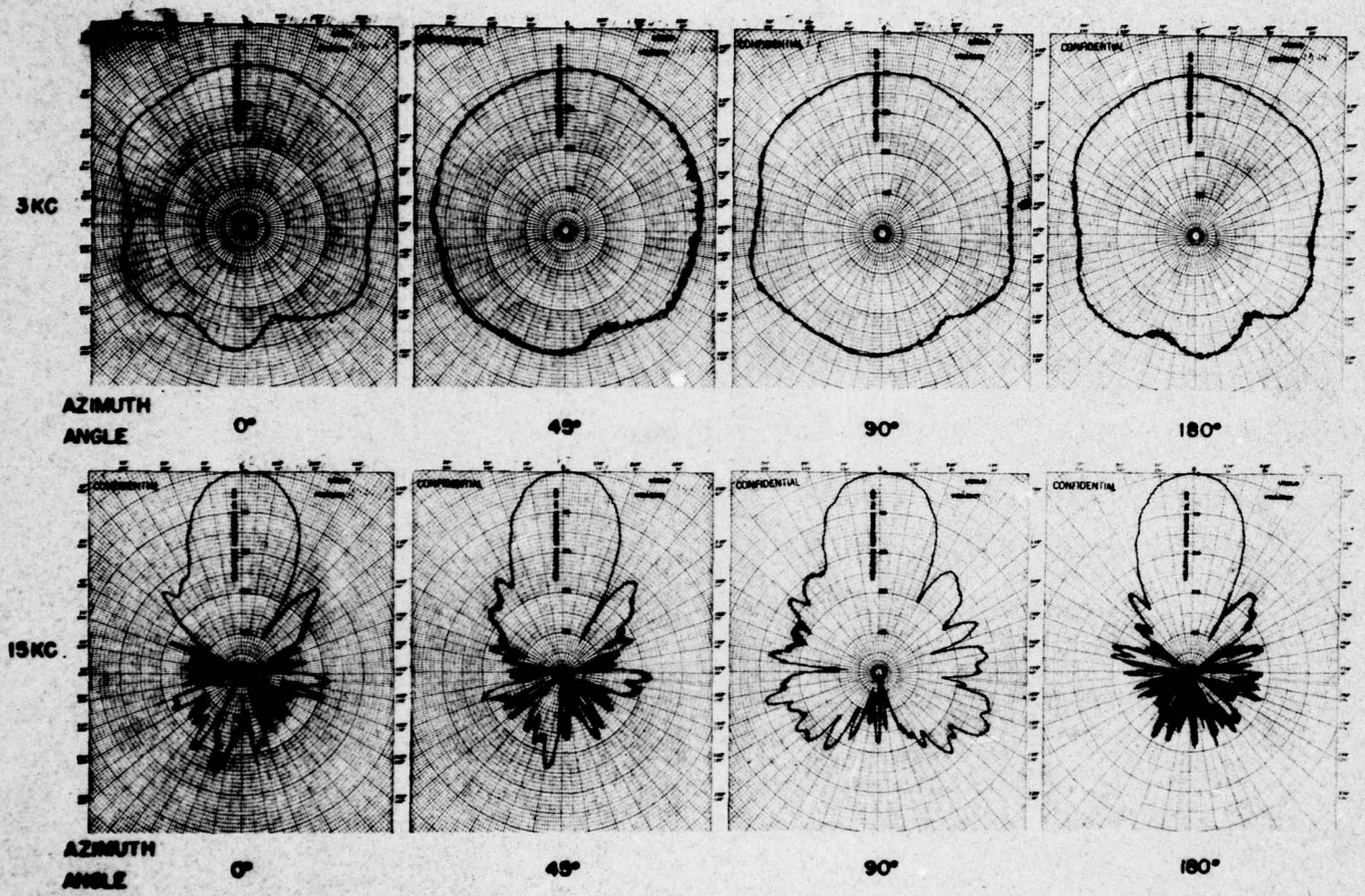


FIG. 24 DOME FIELD PATTERNS, VERTICAL, 3 AND 15 KC, 90° TILT
EDO 60-INCH LUCITE SONAR DOME

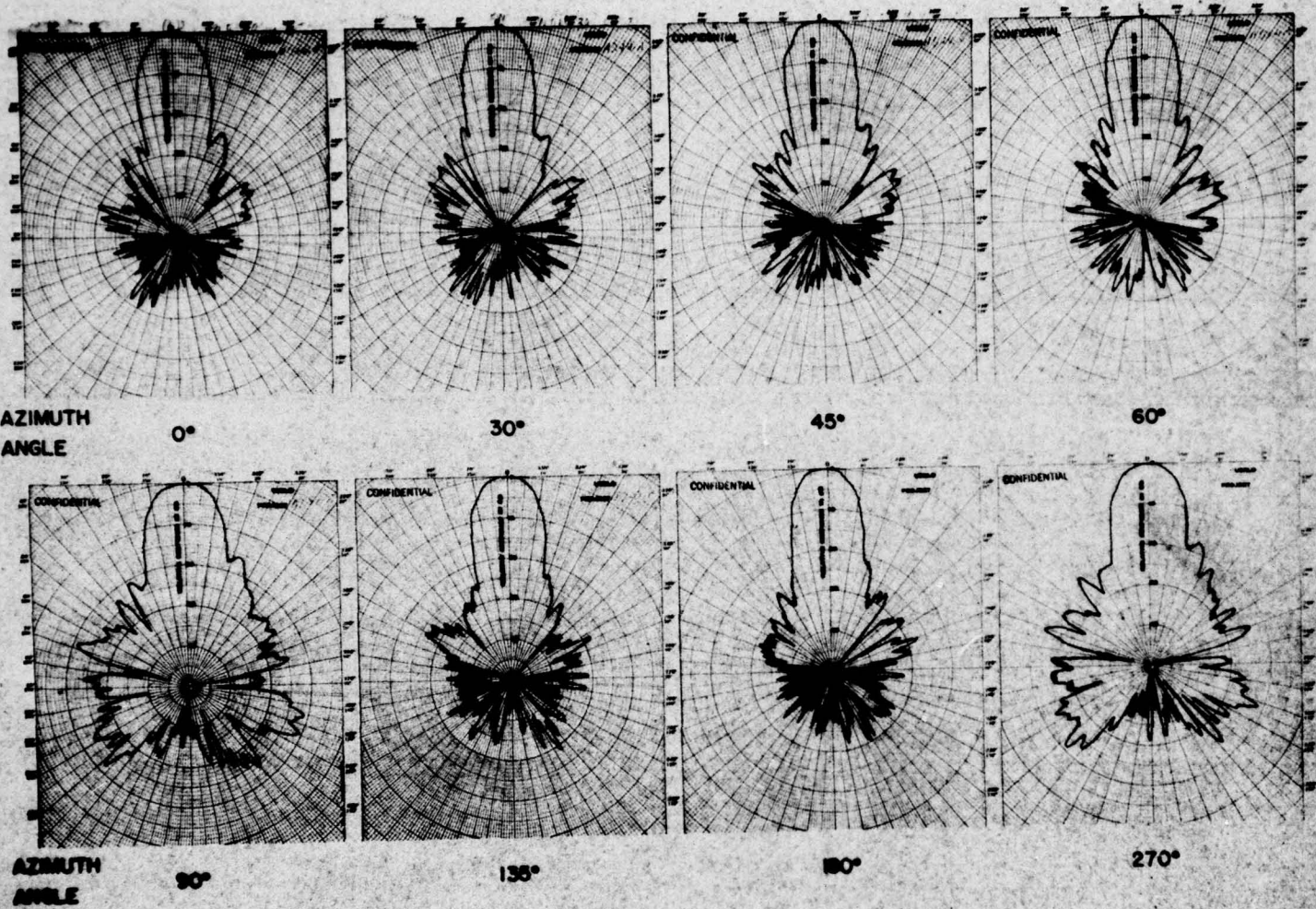


FIG. 25 DOME FIELD PATTERNS, VERTICAL, 24KC, 90° TILT
EDO 60-INCH LUCITE SONAR DOME

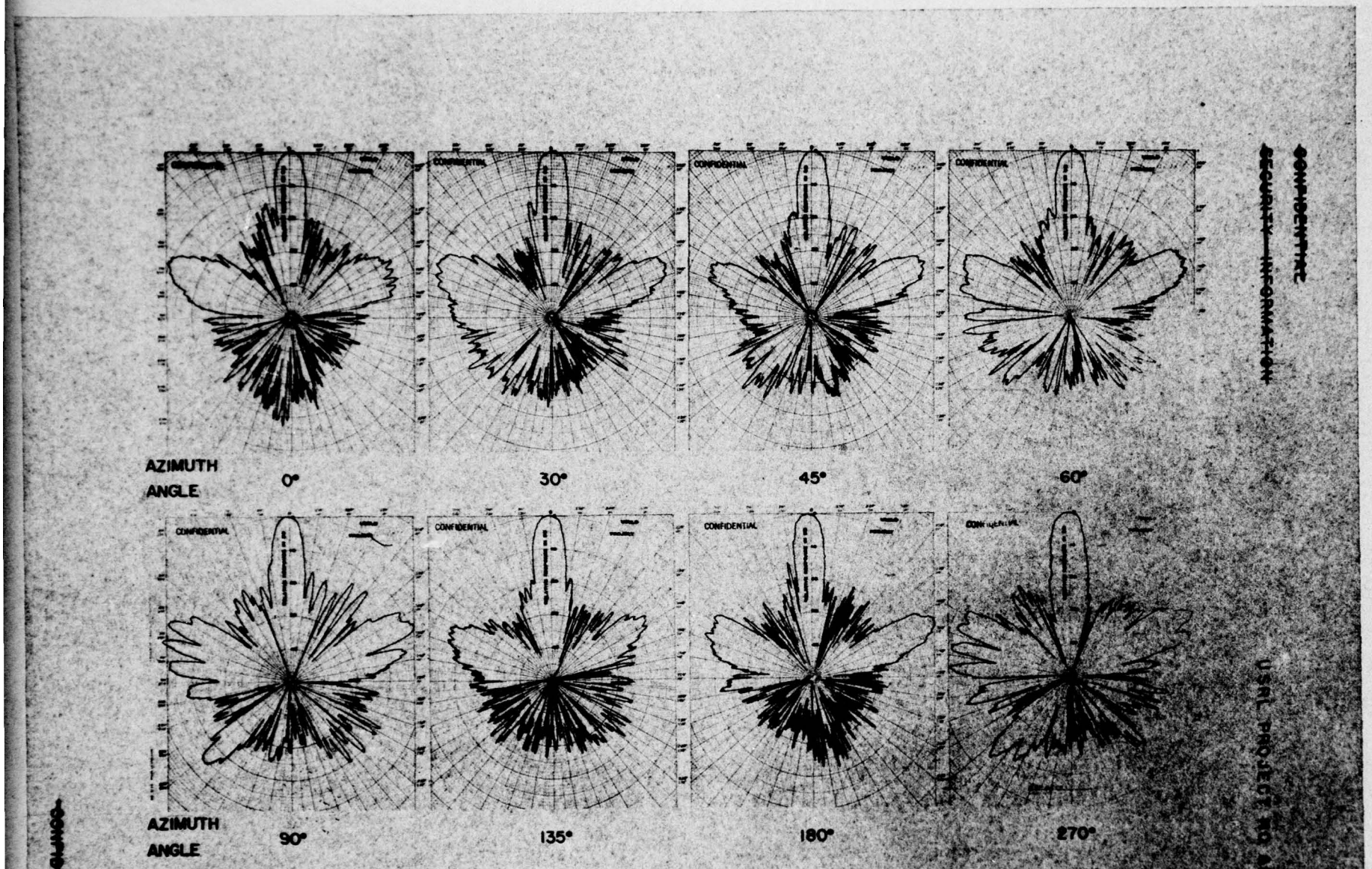


FIG. 26 DOME FIELD PATTERNS, VERTICAL, 45 KC, 90° TILT
EDO 60-INCH LUCITE SONAR DOME

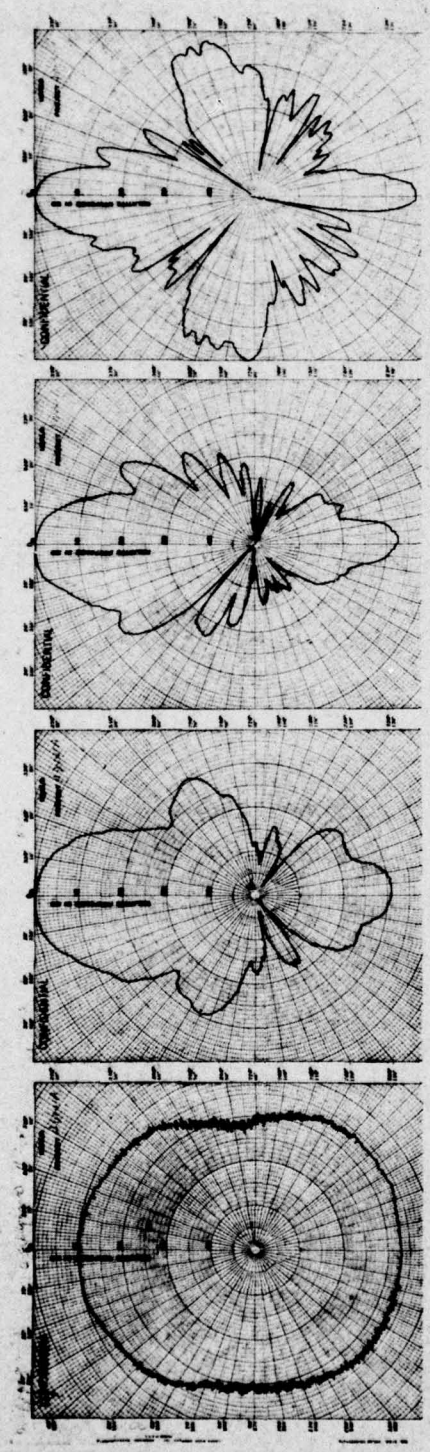


FIG. 27 DOME BEAM PATTERNS, HORIZONTAL
EDO 60-INCH LUCITE SONAR DOME